

E75-10258
CA-142634

Quarterly Progress Report, March - May 1974

SKYLAB EREP Investigation 475, Contract Number NAS 9-13406

INTERDISCIPLINARY APPLICATION AND INTERPRETATION OF
EREP DATA WITHIN THE SUSQUEHANNA RIVER BASIN

"Made available under NASA sponsorship
in the interest of early and wide dis-
semination of Earth Resources Survey
Program information and without liability
for any use made thereof."

Office for Remote Sensing of Earth Resources (ORSER)
Space Science and Engineering Laboratory (SSEL)
Room 219 Electrical Engineering West
The Pennsylvania State University
University Park, Pa. 16802

(E75-10258) INTERDISCIPLINARY APPLICATION
AND INTERPRETATION OF EREP DATA WITHIN THE
SUSQUEHANNA RIVER BASIN Quarterly Progress
Report, Mar. - May 1974 (Pennsylvania State
Univ.) 10 p HC \$3.25

N75-22869

Unclas

CSSL 08F G3/43 00258

Principal Investigators: Dr. George J. McMurtry
Dr. Gary W. Petersen

NASA Technical Monitor: Mr. Martin Miller

June 1974

Quarterly Progress Report

March - May 1974

SKYLAB EREP Investigation 475
Contract Number NAS 9-13406

RESEARCH ACTIVITIES

Lineaments are being plotted on 9 x 9 inch S190A SKYLAB scenes for comparison with those found on selected ERTS-1 enlargements used in the mapping of linear features on the 1960 Geologic Map of Pennsylvania. The location of various types of base metal deposits have been plotted on this map, and the literature search and field work in this connection continue, particularly in the Huntingdon - Mount Union area and along the Bald Eagle Ridge between Curtin Gap and Bellefonte.

The following data sources are being used in an intensive study of linear features at all scales along Bald Eagle Mountain:

SL4	Pass 73, 4 Jan 74, S190A, Rolls 57 and 58, Frame 315 S190B, Roll 91, Frame 322
ERTS	Scene 1045-15247-7, 6 Sep 72 Scene 1243-15253-7, 23 Mar 73
U2	Flight 73-009, 25 Jan, Roll 014, Frames 82257-83300 Flight 74-016, 5 Feb, Roll 023, Frames 6113-6115 and 6119-6120 Flight 74-060, 25 Apr, Roll 17, Frames 66-68 and 102-104
RB57	Mission 248, 30 Aug 73, Roll 103, Frames 243-247
C130	Mission 226, 12 Jan 73, Roll 2, Frames 124-143 Roll 12, Frames 142-193 Mission 230, 15 Apr 73, Roll 74, Frames 224-244 Roll 91, Frames 100-165 Mission 258, 12 Feb 74, Roll 145, Frames 1-18 Roll 156, Frames 90-143
C54	Mission 183-2, 10 Jan 73, Roll 202-1, Frames 19-88

In several other areas of Pennsylvania, the resolvability of structural geologic features such as faults, lineaments, and folds, as well as specific rock types, is being studied on SKYLAB, ERTS-1, and Aircraft (including U2) scenes, and by ground-based surveys.

A plane table map, started in March, and the detailed geologic study of a new road cut in the Tyrone area has been completed. This is the first good exposure of the Helderberg, Oriskany, and Hamilton formations in the Bald Eagle Valley. This exposure is being used as the ground truth control for extending geologic contacts along the linear patterns parallel to the Allegheny front that appear on SKYLAB and ERTS imagery.

SKYLAB photography is being used in conjunction with coverage from ERTS-1, U2, C130, and ground-based geophysical surveys to investigate the origin of a thermal hot springs area near Shermansdale, Pennsylvania. There are indications that the hot spot is associated with a deep pluton, or with lineaments that pass through the area, and possibly with diabase dikes that crop out in the vicinity.

The study of the applications of SKYLAB and ERTS lineaments to ground-water explorations and problems in geologic engineering is continuing. To date, more than 600 water wells have been inventoried within a 600 square mile region. Independent of the inventory work, a significant data base is available through the over 2000 hours of pumping tests which have been run on 100 of these wells, starting as early as 1961, with much of the work done from 1965 into the present. These tests have been funded from various sources; among them are the Institute for Research on Land and Water and the Mineral Conservation Section, both of Penn State; contracts for public water supplies; and individual well owners. In the latter cases, personnel from the Department of Geosciences and Mineral Conservation Section have assisted in well location and testing, enlisting the cooperation of the well owners for data collection. Data points from the tests have been compiled and reviewed for use in the analysis of well yields to determine the significance of lineaments in excess of one mile in length. The data points have been ranked by topographic and geologic setting, well radius, depth, duration of testing, etc. Yields are being standardized to a common well radius, depth of penetration, and pumping duration. This work is continuing as wells become available for testing, because a number of wells must be located within each hydrogeologic setting to insure a statistically significant sample.

RELATED ACTIVITIES

In a master's thesis project, major verification information has been provided by SKYLAB S190B photography for land use mapping from ERTS MSS digital data. The objective of this study is to compare classifier performance on a relatively simple data site, i.e., where relatively large areas of homogeneity exist. An area along the Allegheny River, just west of Oil City, Pennsylvania, was chosen primarily because of the presence of large visually uniform areas and the availability of unbanded and cloud-free ERTS and SKYLAB data for the scene. The area is very heavily forested.

It was decided to do a five-class land-use analysis on the area, restricting the classes to water, city (urban and suburban), agricultural land (of all types), forest (all kinds), and abused land (strip mines, etc.). This necessitated making each of the latter classes broad enough to include all of the various subclasses which could conceivably be formed in other analyses with these data. Making these classes broad involved the definition of classes using several different training areas for each class, as well as breaking down some classes into two or three subclasses. For example, individual

training areas were used for the three types of forest in the scene (deciduous, coniferous, and shaded trees), but in the resultant map these categories were given the same "forest" mapping symbol. Only one water class (for the Allegheny River) was needed.

SKYLAB photographs provided assurance of training area homogeneity. It was decided that lower altitude photos would not be necessary since a relatively non-detailed classification map was sought. Another source of ground truth was a set of recent USGS topographic maps for the area.

The SKYLAB data used was frame number 342 of roll number 85 (S13, S190B). The data was taken on September 10, 1973 (orbit 30). The film was five inch by five inch black and white, and the wavelengths measured were .5 to .7 μ m.

The ERTS data used in this phase of the research was taken from scene 1028-15295, obtained on August 20, 1972. All four MSS channels were used.

A very detailed process of "eyeball" point-by-point comparison of the SKYLAB photography and the computer processed classification map, from ERTS data, was used to determine classifier accuracy. The care with which this was done, however, made this procedure almost as accurate as the zoom transfer scope (ZTS) superposition technique. An attempt to use the ZTS with the SKYLAB photo was made, but it was found that the difference in scale between the photograph and the computer-produced map necessitated reducing the computer map to such a scale as to make individual mapping symbols indistinguishable. Magnifying the SKYLAB photo an equal amount made class boundaries unobservable.

During analysis of the data it was realized that, due to the similarity of some land areas (primarily abused land) and roads, railroad tracks and large oil bins, a large number of the urban signatures were being misclassified as abused land. This lowered the accuracy of classification below an acceptable level. Upon reference to the topographic maps, it was found that most of the area originally classified as abused land actually fell into the above categories. Since these categories could not properly be put into any of the five mapping categories, they were lumped into an "other" category. By this process, percentage classification of all classes was acceptable without penalizing the classification of any one of the original five classes. The presence and locations of the various "other" categories were determined by means of the ZTS, superimposing the topographic map onto the computer map.

Several preprocessing and classification algorithms in the ORSER system of programs were compared. The numerical classification results will be discussed and the resulting classification maps will be shown in the thesis.

A service contract is being negotiated between the Pennsylvania Department of Environmental Resources, The Pennsylvania State University and the Consulting Engineering firm of Skelly and Loy of Harrisburg, Pennsylvania. The demonstration study has been funded by the Environmental Protection Agency on a matching basis with the Department of Environmental Resources and intends

to demonstrate that the connector well method of abating pollution derived from abandoned or active deep mines (see appended figure) is feasible and cost competitive with existing abatement techniques. Seven candidate mines, now inactive, have been examined and are being considered in detail for possible use in the demonstration. An important criterion in their selection is that they contain the intersection of a number of lineaments within mined-out regions. Lineament intersections mapped on various scales, using aircraft, SKYLAB and ERTS-1 data will serve as the sites for up to four connector wells planned in this pilot demonstration study. Observation wells will also be located on lineaments. The final mine named in the study will be subjected to detailed examination using remote sensing data. The concept demonstrated here is receiving widespread interest and it is expected that EPA will soon fund pollution abatement demonstrations of mine dewatering used to abate pollution from active mines.

The Susquehanna Economic Development Agency, in Lewisburg, has initiated, with ORSER, a feasibility study for a land-use inventory of their district. It is expected that SKYLAB data will serve as excellent "ground truth" in areas where it is available.

In preparation for using SKYLAB and aircraft MSS data (14 to 24 channels) on systems such as the GE Image 100, the ORSER SUBSET program has been modified to output in the ERTS mode (4 channels). The data were transformed into 4 channels using the transformation matrix output from the CANAL program. The resulting program has been designated as the separate ORSER program SUBTRAN.

A method of preparation of computer output maps for the ease of handling and publication has been described in ORSER-SSEL Technical Report 3-74, GRAY SCALE PRINTING AND PHOTOGRAPHIC REDUCTION OF LARGE AREA COMPUTER GENERATED MAPS, by A. David Wilson and Richard E. Ackley. It is expected that this method will lend itself well to the presentation of SKYLAB data.

Development, installation, and evaluation of a color display system for the ORSER laboratory has recently been authorized by the Applied Research Laboratory at Penn State. The system will be capable of displaying the results of standard software installed on the general purpose computer at The Pennsylvania State University. Software has been specifically developed by ORSER/SSEL for the purpose of analyzing and classifying remotely sensed (by aircraft and satellite) earth resources data. In addition, recommendations will be developed for expansion of the system, with particular emphasis on speed-up procedures for more effective man-machine interaction and direct digitization, display, and enhancement of ERTS, SKYLAB, and aircraft imagery and photography.

**ORIGINAL PAGE IS
OF POOR QUALITY**

Two papers describing ORSER methods with potential application to the processing of SKYLAB data were presented at the Third Annual Remote Sensing of Earth Resources Conference, March 25-27, held at the University of Tennessee Space Institute, Tullahoma:

ORSER-SSEL Technical Report 7-74

A METHOD FOR SPECIFYING REMOTELY SENSED UNITS FOR SOIL SAMPLE POINTS
G. A. May, G. W. Petersen, F. Y. Borden, and D. N. Applegate

ORSER-SSEL Technical Report 9-74

THE PENN STATE ORSER SYSTEM FOR PROCESSING AND ANALYZING ERTS AND
OTHER MSS DATA

G. J. McMurtry, F. Y. Borden, H. A. Weeden, and G. W. Petersen

ORSER-SSEL Technical Report 10-74, APPLICATION OF REMOTE SENSING TO NATURAL RESOURCE AND ENVIRONMENTAL PROBLEMS IN PENNSYLVANIA, by D. P. Gold, S. S. Alexander, and R. R. Parizek, has been published in EARTH AND MINERAL SCIENCES, Vol. 43, No. 7, April 1974. The significance of ERTS and SKYLAB data are discussed in this paper (see abstract, appended).

Dr. Petersen attended the Steering Committee meeting for the Large Area Crop Inventory Program (LACIP) training courses in Houston.

Dr. Weeden attended the session on Remote Sensing at the American Congress on Surveying and Mapping, jointly sponsored by the American Society for Photogrammetry and the American Congress for Surveying and Mapping.

Dr. Gold visited the offices of the Department of Environmental Resources, in Harrisburg. The use of ERTS, SKYLAB, and aircraft data was discussed - especially in connection with the location of ore deposits and the solution of structural problems presented by weaknesses along crustal lineaments and fracture traces.

ORSER has advised the Northwest Pennsylvania Regional Planning and Development Commission on submission of a proposal for an environmental geology study in support of land-use planning, to be submitted to the National Science Foundation on the RAN program.

ORSER was visited by two representatives of the Lackawana County Planning Commission. Data types - including SKYLAB - were shown and the Tektronix terminal was demonstrated. The Commission is exhibiting a growing interest in comprehensive land use planning processes, with the use of ERTS, SKYLAB, and aircraft data being considered.

Other visits to ORSER by representatives of public agencies included the Pennsylvania Topographical and Geological Survey, the Clearfield County Planning Commission, the Pennsylvania Department of Environmental Resources, and the Hawk Mountain Sanctuary (this latter agency for imagery to plot hawk flight paths). A professor in remote sensing at Syracuse University (SUNY), Dr. Tom Lillesand, visited ORSER during this period, as did a representative of the Geoscience and

ORIGINAL PAGE IS
OF POOR QUALITY

Environmental Applications Division of Earth Satellite Corporation, Washington, and a representative of Consolidated Natural Gas Service Company with an interest in storage and location of natural gas. Dr. Pennypacker was visited by Herman Frinking, from the Laboratory of Phytopathology, Agricultural University, Wageningen, The Netherlands. During such visits, ORSER personnel routinely demonstrate laboratory facilities, show the various types of photography and imagery on hand from ERTS, SKYLAB, and aircraft passes, and demonstrate the data processing facility using the Tektronix terminal.

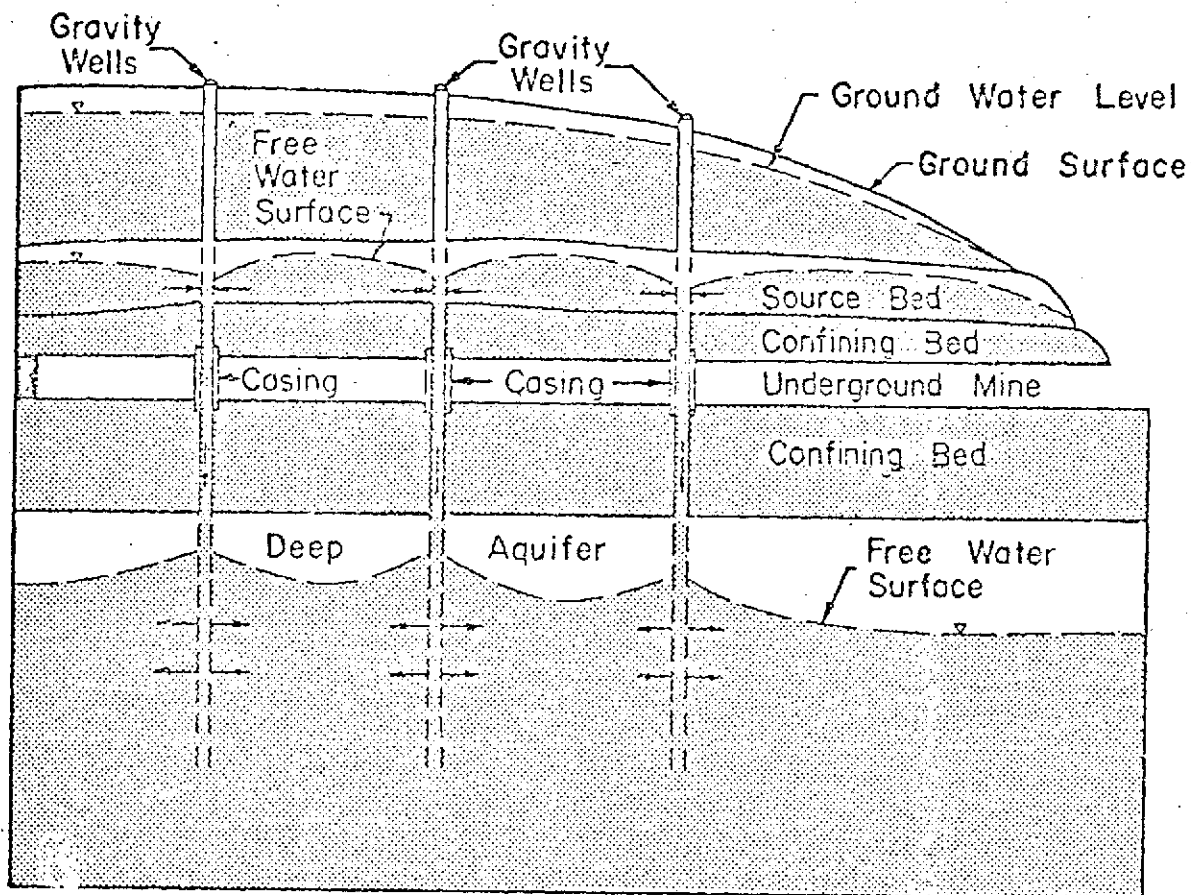
ORSER has a continuing program in education, in an effort both to instruct graduate and undergraduate students in the techniques used to process remote sensing data, and to inform the academic community and the public of progress in the application of ERTS, SKYLAB, and aircraft derived data to problems of the State and of society. Dr. Borden again offered his graduate/undergraduate course, REMOTE SENSING OF EARTH RESOURCES during the spring term. (A course outline is appended.) Mr. Henninger demonstrated the use of the Tektronix terminal to students in a graduate-level course in Agronomy (SOIL MAPPING), and also gave a talk to a class in Landscape Architecture, "Remote Sensing Applications to Regional Planning." Graduate student Eric Fritz gave a talk in a graduate course in Plant Pathology, "Remote Sensing of the Occurrence and Progression of Plant Disease," and various graduate and undergraduate students are using the new SKYLAB photography, as well as ERTS and aircraft scenes, for reference in their projects.

DATA FLIGHTS AND RECEIPTS

The following data relating to the SKYLAB project were received during this reporting period:

SL 2 & 3	Hassablad hand-held photography, 70 mm
SL 3	S190A 9 inch photography
	S190B 5 inch photography
U2	74-016 photography, 70 mm
C130	Mission 258, photography and preliminary MSS imagery
C130	Mission 238, MSS tapes, Reconofax IV Thermal IR Tapes

Three U2 flights were made over Pennsylvania during this period: 74-060A, 74-078, and 74-081.



Gravity drainage wells used to dewater source beds above deep mines located in regional ground-water recharge areas. Three distinct water tables are shown which commonly occur in western Pennsylvania where less permeable coal bearing strata overlie more massive and permeable aquifers which serve as regional underdrains. The same systems would work if there was but one water table, provided that ground-water flow is downward.

**ORIGINAL PAGE IS
OF POOR QUALITY**

ABSTRACT

ORSER-SSEL Technical Report 10-74

APPLICATION OF REMOTE SENSING TO NATURAL RESOURCE AND ENVIRONMENTAL PROBLEMS IN PENNSYLVANIA

David P. Gold, Shelton S. Alexander, and Richard R. Parizek

Various aspects of remote sensing, the electromagnetic spectrum, natural and synthetic detectors, radiometers and spectrometers, active and passive responses, attenuation phenomena, imaging methods (scanners, cameras), and techniques (digital and photographic), are reviewed. Imaging platforms and systems are compared in a table relating geologic features and map type to six orders of scale and the optimum observation platform. The scales, gigascopic (>1000 km), megascopic (10 km to 1000 km), macroscopic (10 m to 10 km), mesoscopic (1 cm to 10 m), microscopic (10 μ to 1 cm), and submicroscopic (1 \AA to 10 μ), and their practical range of extension by mosaicing or enlarging are given for use on problems of synthesis and analysis.

The available remote sensing data for Pennsylvania and the relative costs of acquisition are summarized in tabular form. These data have been used a) to map gross lithologic boundaries in parts of the State on bands 5 (green-yellow) and 7 (infrared) of ERTS-1 imagery, b) to map megalineaments on a mosaic of ERTS-1 imagery (band 7, at a scale of 1:1,000,000), c) to map lineaments on a macro- and megascopic scale on enlargements (at a scale of 1:250,000) of ERTS and SKYLAB imagery, and d) to plot coincidences between metallic ore occurrences and certain lineaments. The subsurface nature of lineaments is inferred from water well yields, water well records, and observations in some underground mines, to be zones of fracture or joint concentrations. They are thought to be recurrent zones "working" in response to oscillations between crustal blocks.

Digital data from the imaging platform contain more information than the images, especially if all the channels are used simultaneously. A computer classification map of a strip mine area near Kylertown, using three ERTS MSS channels, demonstrates the effectiveness of the method and its potential application for inventories of certain features.

ORIGINAL PAGE IS
OF POOR QUALITY

FORESTRY 597 - REMOTE SENSING OF EARTH RESOURCES

Spring Term 1974

The technology and applications of remote sensing to earth resources will be surveyed. Emphasis will be placed on computer analysis of multispectral scanner (MSS) remote sensor data acquired by spacecraft and airplane.

The methods of analysis of MSS data will be covered in detail. Computer programs developed through the Office for Remote Sensing of Earth Resources at The Pennsylvania State University will be used in practicum work. Data from the NASA-ERTS-1 satellite will be used. The course will consist of two lectures and one practicum per week. The time and place for classes will be arranged during the first three days of the term. Prerequisites to the course are Math. 61 and 62 and three credits in statistics. Students with alternate equivalent backgrounds will be accommodated after consultation with the instructor. The instructor will be Dr. F. Y. Borden, 211 Ferguson Building, Phone 865-8911.

Lecture material will be presented in approximately the following order and times:

1. Introduction to remote sensing (one week)
2. Data collection systems (one week)
3. Preclassification analysis and processing (two weeks)
4. Classification and mapping (three weeks)
5. Applications (three weeks)

Practicum study will be organized in roughly the following way:

1. Imagery, photography, and other support materials
2. Use of the remote job entry system
3. Use and organization of tapes and specification of tapes in programs
4. Use of preclassification programs
5. Use of supervised classification programs
6. Use of unsupervised classification programs
7. Map making and interpretations
- 8-10. Projects